جامعة الأمير مقرن بن عبد العزيز
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AE 475 – Surveying

Lecture 2

Fundamental concepts and applications

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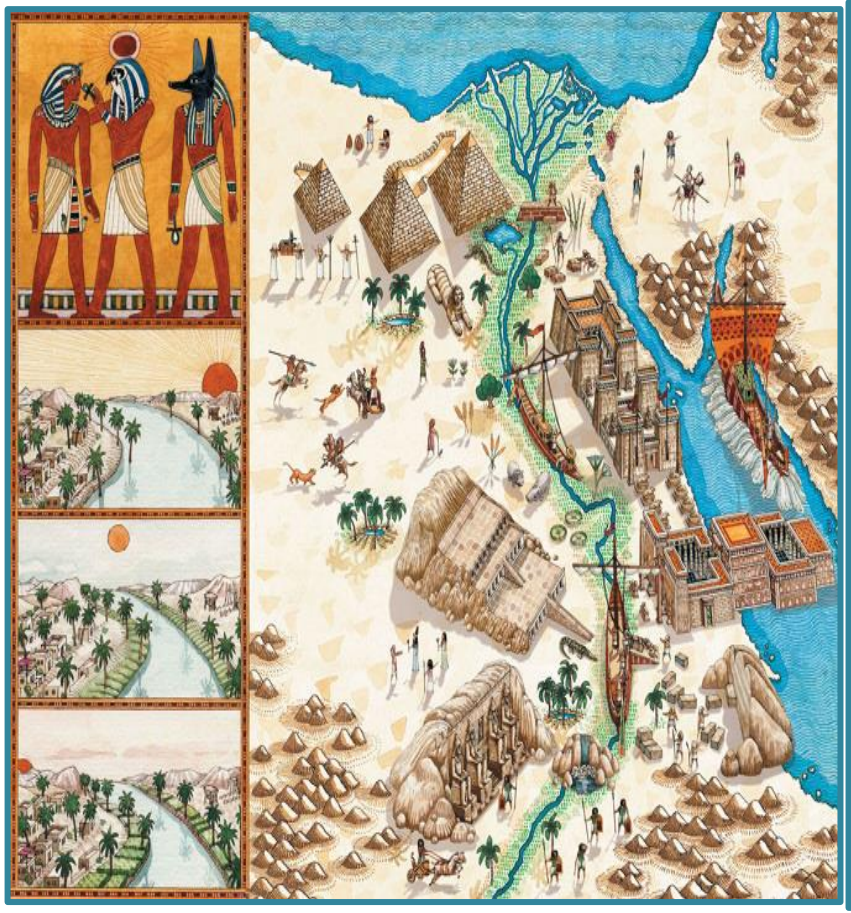
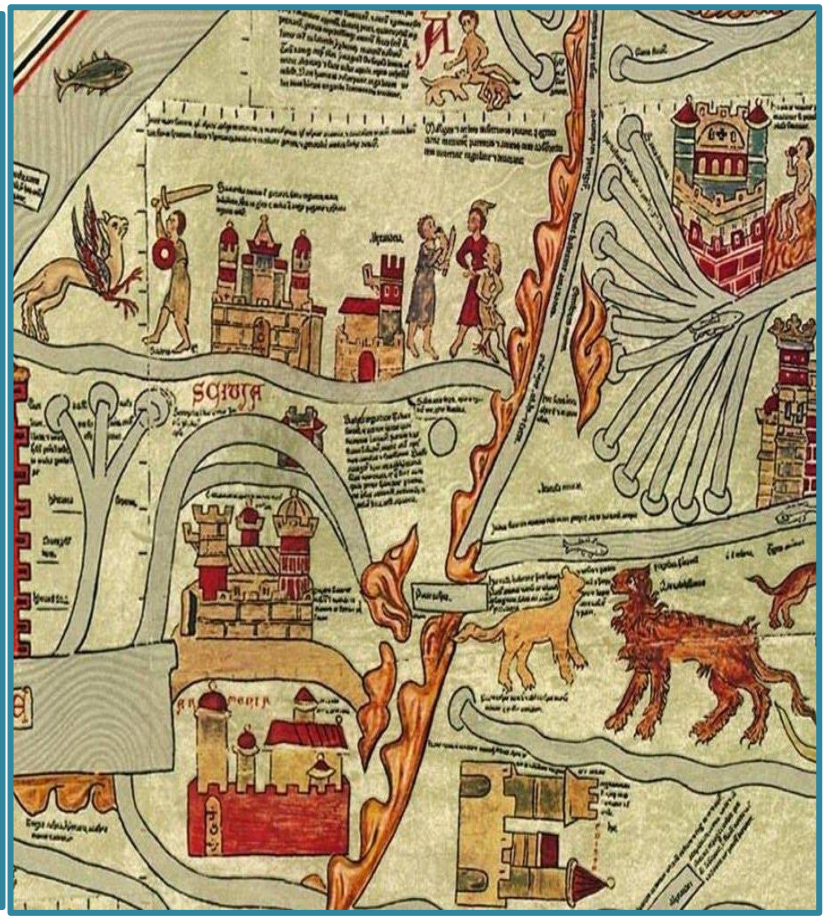
Introduction

Surveying is a profession with a very long history. Since the beginning of property ownership, boundary markers have been required to differentiate one property from another. Historical records dating to almost 3000 B.C. show evidence of surveyors in China, India, Babylon, and Egypt.





SURVEYING DEFINED

- **Surveying** has traditionally been defined as the art and science of measuring distances, angles, and positions, **on** or **near** the surface of the earth.

- **Surveying (geomatics)** can be regarded as that discipline which includes all **methods for measuring and collecting information** about the physical earth and our environment, **processing that information**, and **disseminating a variety of resulting products to a wide range of clients.**

SURVEYING DEFINED

- Examples for engineering work require surveying:
  1. Determine the location of points on the earth's surface.
  2. Determine the elevation of a point.
  3. Collect data for a surface plot.
  4. Mapping the location of utilities.
  5. Calculate the distance between two points.
  6. Determine the position of boundary lines.
  7. Determine areas of land.

The work of the surveyor consists of 5 phases:

1. Decision Making – selecting method, equipment and final point locations.
2. Fieldwork & Data Collection – making measurements and recording data in the field.
3. Computing & Data Processing – preparing calculations based upon the recorded data to determine locations in a useable form.
4. Mapping or Data Representation – plotting data to produce a map, plot, or chart in the proper form.
5. Stakeout – locating and establishing monuments or stakes in the proper locations in the field.

Types of Surveying

Classification

Surveying types

1. Depending on the method of survey, surveying can be divided into two:

   a) Aerial survey is the one carried out in the air or space with the use of aircraft or satellites. In this method, the features to be surveyed are photographed or sensed using camera or sensor, then the required information are collected by doing some measurement on the photographs or image.

   b) Ground survey is the kind of survey that takes place on the surface of the earth. In this type of surveying, the features to be surveyed are directly measured by physically touching them.

Surveying types

ground survey

Aerial photograph

Surveying types

2. Ground surveying can be divided into two major sub areas based on the area to be surveyed:

   a) Geodetic survey: it deals with large area of the earth such as the surveys of countries and the earth curvature must be taken into consideration, it is a highly accurate type of survey. Usually the scale of the resulting map is small (1: 100, 000 or smaller)

   b) Plane survey: is the science of measuring and representing natural and artificial features on the ground in a limited area, regarding the earth as flat. Plane survey deals with the relatively small area. It is assumed that the plane surveying method can be applied to an area up to 250 km2. Plane surveying is employed in architectural, engineering, and exploratory activities.

Surveying types

Plane Surveying	Geodetic Surveying
The earth surface is considered as plain Surface (*X* - *Y* dimensions).	The earth surface is considered as curved Surface. Actually, ellipsoid for X and Y dimensions
The curvature of the earth is ignored	The curvature of the earth is taken into account.
Line joining any two stations is considered to be straight	The line joining any two stations is considered as spherical.
The Z - dimension (height) referenced to the mean surface of the earth (Mean Sea Level).	The Z dimensions (orthometric heights) in geodetic surveys are referenced to a mathematical model that represents the Earth
The angles of triangle are considered as plain angles	The angles of the triangle are considered as spherical angles.
Carried out for a small area < 250 km^2	Carried out for an area > 250 km^2

Surveying types

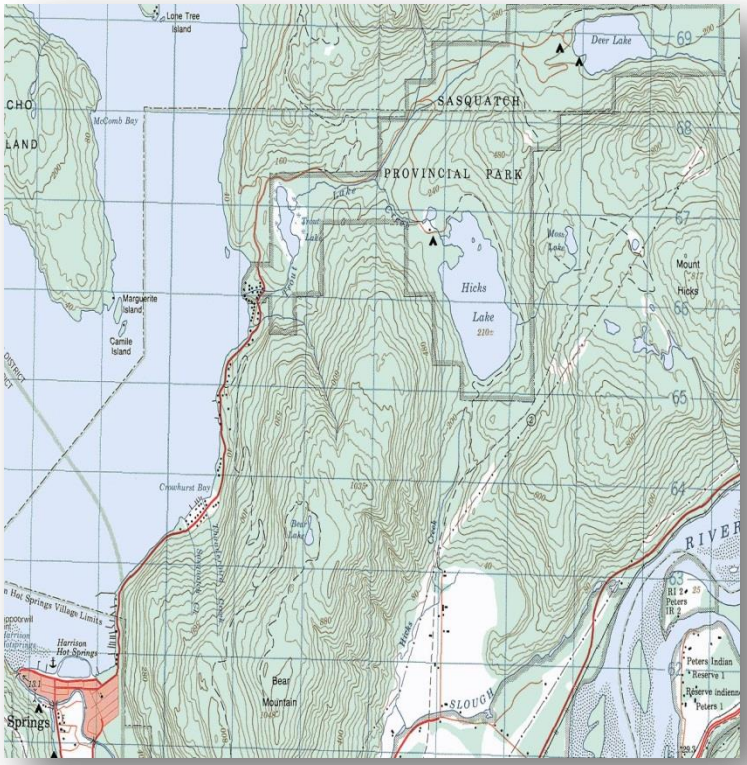
3. Based on purpose of surveying, plane surveying can be divided into the following types:

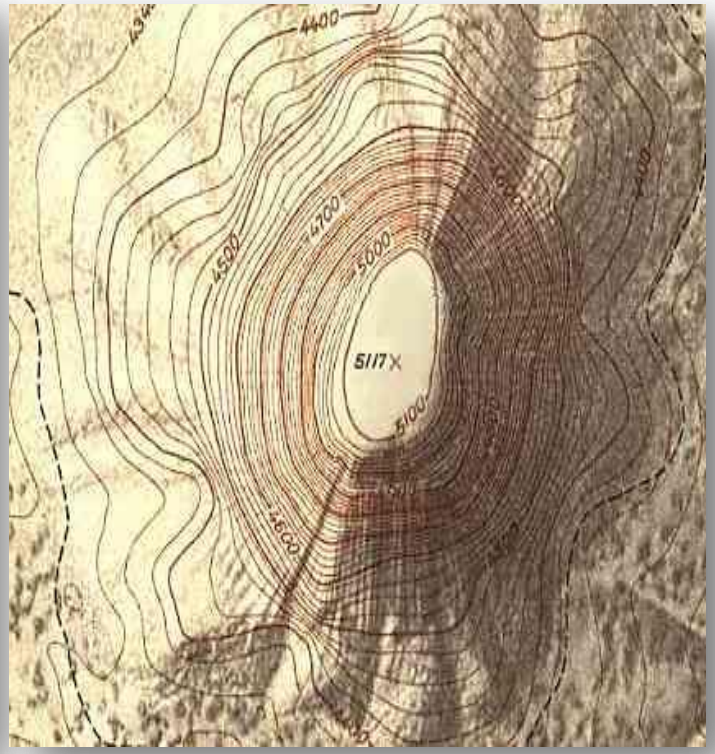
1. Topographic survey
2. Hydrographic survey
3. Route survey
4. Cadastral survey
5. Construction survey

Types Of Surveys

1- Topographic survey:

It determines the position and shape of **natural** and **man-made** features over a given area, usually for the purpose of producing a map of an area.

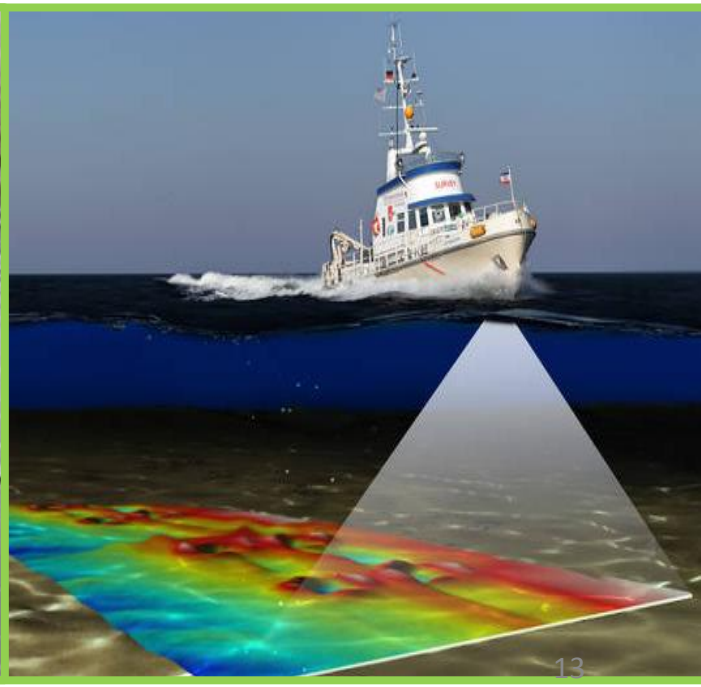




Types Of Surveys

2- Hydrographic survey:

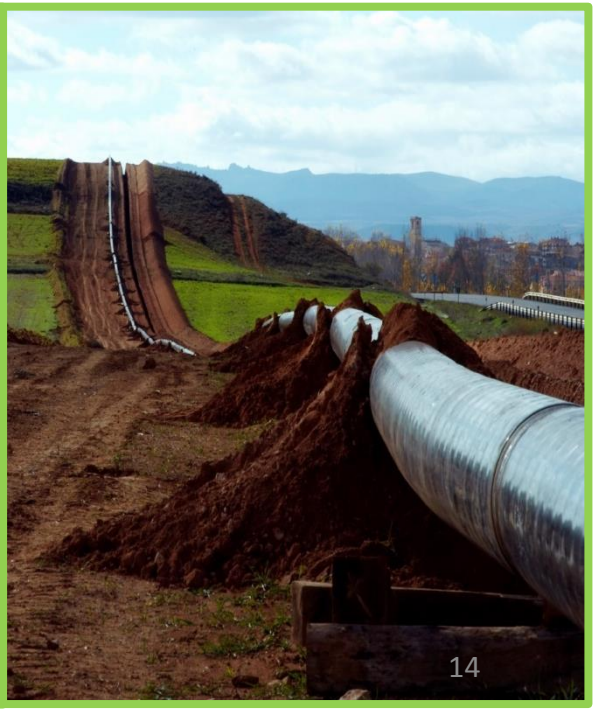
Preliminary surveys that are used to tie underwater features to surface control points. It defines shorelines and depths of lakes, streams, oceans, reservoirs, and other bodies of water.



Types Of Surveys

3- Route survey:

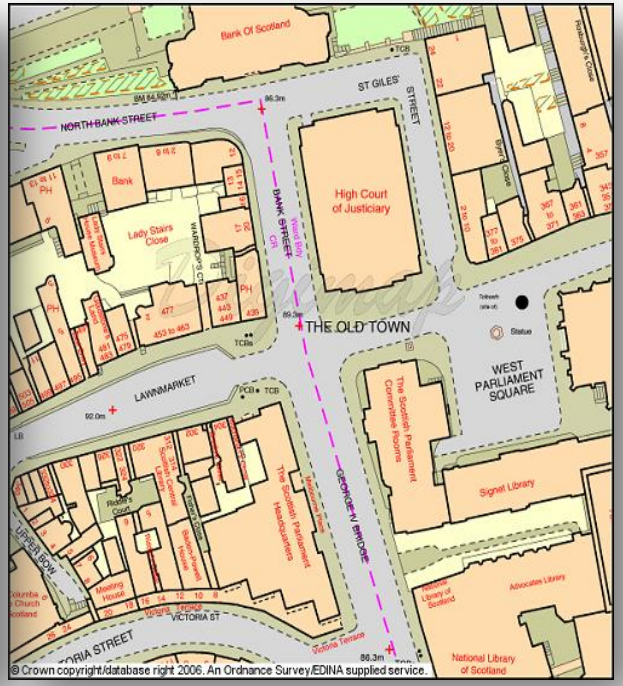
Preliminary, layout, and control surveys that range over a narrow but long strip of land. Typical projects that require route surveys are highways, railroads, electricity transmission



Types Of Surveys

4- Cadastral survey (property survey):

preliminary, layout, and control surveys that are involved in determining boundary locations or in setting out new property boundaries.



Types Of Surveys

5- Construction survey :

layout surveys for engineering works(e.g. line, grade, control elevations, horizontal positions, dimensions, and configurations for construction operations). They also secure essential data for computing construction pay quantities.

Surveying Instrument

1- Theodolite: measure horizontal and vertical angles.

2- The level and rod: measure difference in elevations

3- Steel tape: measure horizontal and slope distances.

4- Total station: measure horizontal and vertical angles

Also measure horizontal and slope distances.

5- GPS (global positioning system) receivers.

Surveying Instrument

Steel tape

Total station

Level

Theodolite

GPS

Scale of survey

- Scales is simply defined as the ratio of the distance between two points on the map to the horizontal distance between the same points on the ground.

As an example if 1 meter in reality is drawn on a map as 1 cm, then the scale is 1:100 (meaning that 1 cm on the map is equivalent to 100 cm in reality).

Scale of survey

- The appropriate scale might be selected based on:

  1- Size of area to be mapped
  2- Map purpose
  3- Size of paper sheet to be used for drawing

- For example the details drawings usually use large-scale whereas country or town maps use small-scale.

- It should be noticed that the scale might differ from one map to another, but should be uniform throughout the same map.

Units of measurements

- Units of measurements are those units used for representation of measure distances, angles, areas and volumes.
- In general there are two systems of units: metric units and foot units.
- The following tables show the units of measurements for lengths, area, volume, and angles:

Units of measurements

Table 1-1 Measurement Definitions and Equivalencies

Linear Measurements	Foot Units
1 mile = 5,280 feet	1 foot = 12 inches
= 1,760 yards	1 yard = 3 feet
= 320 rods	1 rod = 16½ feet
= 80 chains	1 chain = 66 feet
	1 chain = 100 links
1 acre = 43.560 ft^2 = 10 square chains	

Linear Measurement		Metric (SI) Units
1 kilometer	=	1,000 meter
1 meter	=	100 centimeter
1 centimeter	=	10 millimeter
1 decameter	=	10 centimeter
1 hectare (ha)	=	10,000 m^2
1 square kilometer	=	1,000,000 m^2
		100 hectares

Units of measurements

Foot-to-Metric Conversion*	
1 ft = 0.3048 m (exactly)	1 inch = 25.4 mm (exactly)*
1 km = 0.62137 miles (approx.)	
1 hectare (ha) = 2.471 acres (approx.)	
1 km^2 = 247.1 acres (approx.)	

Angular Measurement
1 revolution = 360°
1° (degree) = 60′
1′ (minute) = 60″ (seconds)

Types of errors

No measurement (except count) can be free of error.

Types of errors

1. Random
2. Systematic
3. Natural
4. Personal

Random

- Not predictable
- Tend to be small and will usually cancel themselves.
- Best controlled by repeating measurements.

Systematic

- Usually caused by damaged equipment.
- Error tends to multiply (occur for each measurement)
- Best control is calibration of equipment.

Natural

- Factors in the environment that can cause error.
  - Curvature
  - Refraction
- Must use correction values

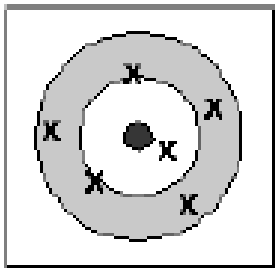
Personal

- Commonly called blunders
- Best controlled by following established procedures.

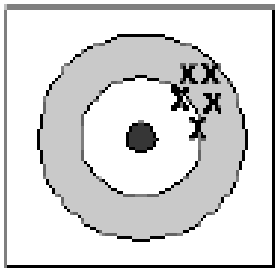
ACCURACY AND PRECISION

Accuracy is the closeness between measured and the true value

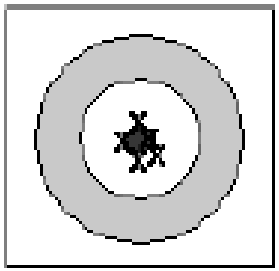
Precision is the closeness between the measured values



Accurate, not precise
(the average is accurate)



precise
not accurate



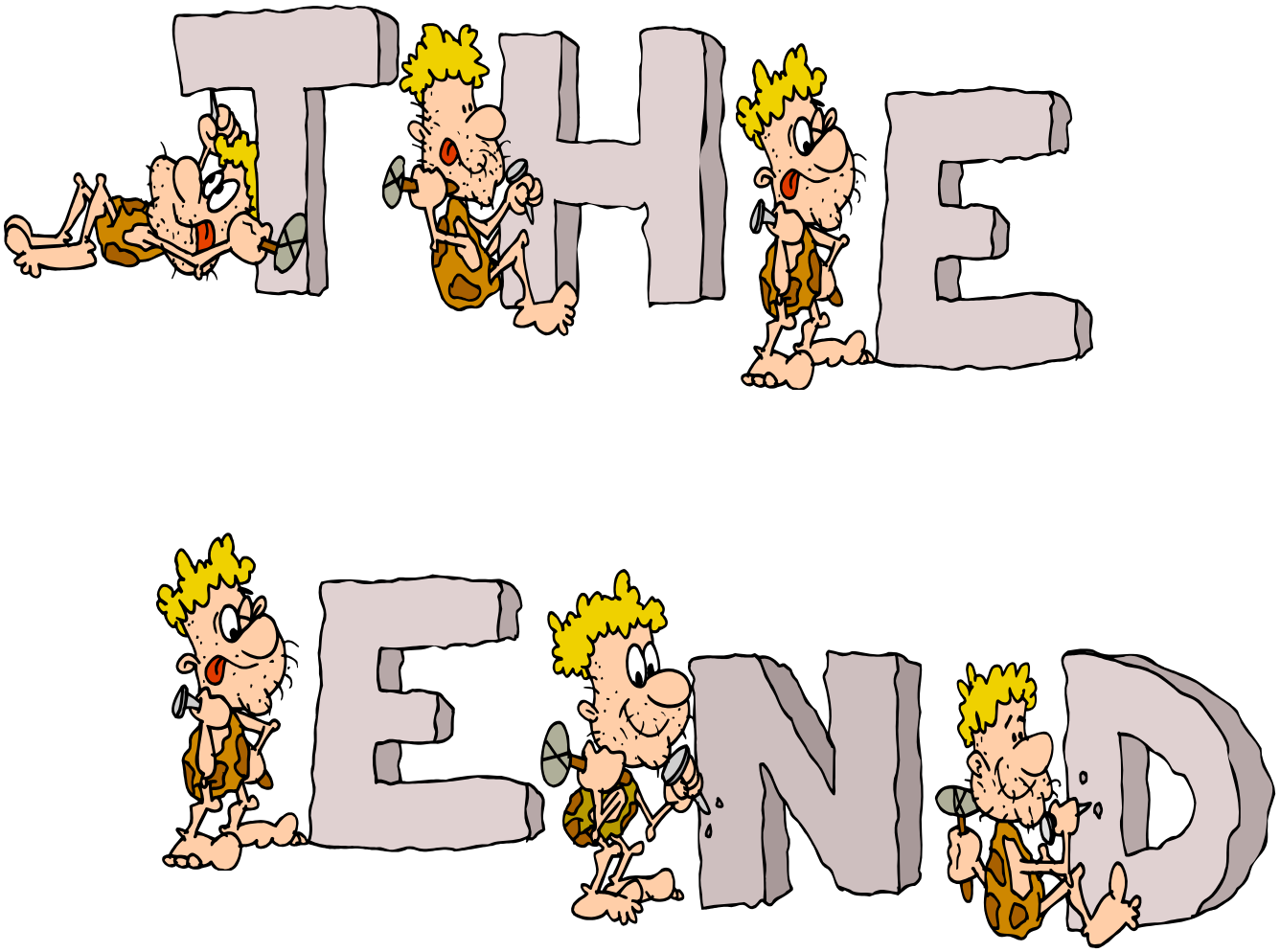
accurate
and
precise

Field Notes

- Field notes are the permanent record of field procedures and the data collected in those procedures.
- Field notes should be made carefully.
- It is a common tendency to crowd information onto the pages. Paper is cheap. Information isn't. Do not crowd information onto the page.
- Sketches should be drawn to approximate scale with care taken to preserve the relative positions and orientations of features.
- Sketch the plan of the whole area on one sheet of paper. Show all details such as detail out lines of buildings, edges of paved areas and roads, footways, walls, hedges, fences, trees, telegraph poles, transmission lines, etc

About this note

- These notes based on
- Barry Kavanagh, Tom Mastin, (2014), **Surveying: Principles and Applications**, 9th Edition, Pearson
- Lectures notes from Eng. Mohamed Barakat (former UPM lecturer)
- Lectures notes from Dr. Ibrahim Mahamid (Associate professor in UPM)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